Application of Poly Aluminum Chloride In Shenzhen Water Supply

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At present, there are two kinds of main coagulant: inorganic coagulant and organic coagulant. Aluminum sulfate and poly-aluminum chloride (PAC) have the highest output. According to the statistic report, the annual output of PAC is over 300 thousand tons. And with its increasing output, PAC has become dominant coagulant.

It is shown in practical applications that PAC has a coagulating effect as good as 2-3 times of traditional aluminum salt. With its much lower price in comparison with organic coagulant, it has a great advantage in improving water quality. PAC has such characteristics:

1)❄ Floccs forms rapidly. It needs a short time to react and settle down;

2)❄ With the same dosage, the pH value reduces less to use PAC than other inorganic coagulant, especially when with the highly turbid water is treated, we may use less lime to adjust the pH value of treated water.

3)❄ It has a wide range of dosage, and it is well suitable for the variety of turbidity, alkalinity, organics in the watr. Compared with Aluminum sulfate_it has a better coagulation effect even in lower temperature_T<10__.

There are some problems in application that coagulation doesn't effect expectantly. In a given condition of raw water physical and chemical properties, flocculent kind, purification, it is the key factor to get high water output with high quality water and low cost whether coagulant is used correctly. Considering the practice of liquid PAC used in Shenzhen, an experiment was carried out with different dosage, diluting times, and different settlement time. It is expected that the result of the experiment will give reference for the water works to use PAC in water treatment.

1. EXPERIMENTS

The raw water used in the experiments was taken from Donghu Reservoir. It's temperature is 20_ and its turbidity is 5 NTU.

The liquid PAC was produced by Qingyuan Water Purification Materials Co. Ltd. It has the Al_2O_3 content of 10.88% and the alkalinity of 78.2%. The liquid PAC was diluted into a solution with the Al_2O_3 content of 8.05% and a density of 1.180. When it was used dilute solutions with 10 times and 10 times were prepared for instant use, respectively.

6 beakers respectively. Then the coagulant solutions were added to each beakers at the same time and was stirred for 2 minutes with a rotate speed of 150 rotation/min, for 5 minutes with a speed of 50 rotation/min, their residual turbidity was measured after settled for 10 minutes.

Instruments used in experiment included a stirrer of model SYW-881 made in Hubei Qianjiang General Instrument Factory and a turbidity meter of model HACH-2100N made in the USA.

2. THE EFFECTS OF THE COAGULANT

Under the same experiment conditions, the effects of the coagulant dose on the coagulation and settlement effect were tested by means of monitoring residual turbidity at the same time. The experiment was conducted in different dosages, and their turbidities after settled for 20 minutes and 60 minutes were listed in table 1.

Table 1 Effect of PAC dosage on turbidity removal percentage

Settling time(min)		20		60	
Doseage	**C_A (mg/L)**	**residual turbidity**	**removal percent(%)**	**Residual turbidity**	**removal percent(%)**
0.5ml	0.475	4.20	0	3.70	11.9
1.0ml	0.950	3.22	23.3	1.95	53.6
1.5ml	1.425	1.04	75.2	0.76	81.9
2.0ml	1.900	0.71	83.1	0.35	91.7
2.5ml	2.375	0.62	85.2	0.24	94.3
3.0ml	2.850	0.52	87.6	0.16	96.2

Note: 1. The turbidity in the raw water is 4.20NTU (C_A was the Al_2O_3 concentration in water).

The relationship between residue turbidity and PAC dosage, the effect of dose on coagulation and settlement was shown in fig.1 as follows:.

1. C_A when is less 1.425mg_L, the dose was too little, and it had high turbidity. So it was effective to increase turbidity removal percent with the dose increase

2. $1.425 \leq C_A$_1.900mg_L, with the increase of PAC dose, turbidity removal percent increased clearly with the increase of PAC dose. This section was the optimal range dose for its high turbidity removal percentage, lowest residual turbidity and least PAC cost.

3. When $C_A \geq 1.900$mg_L, with the increase of PAC dose ,turbidity riddance ratio increased very slowly. It showed that was more than 1.900mg/L of C_A was unnecessary.

The same result came out in the experiment, with 8% of Al_2O_3 and its 10 times dilute solution.

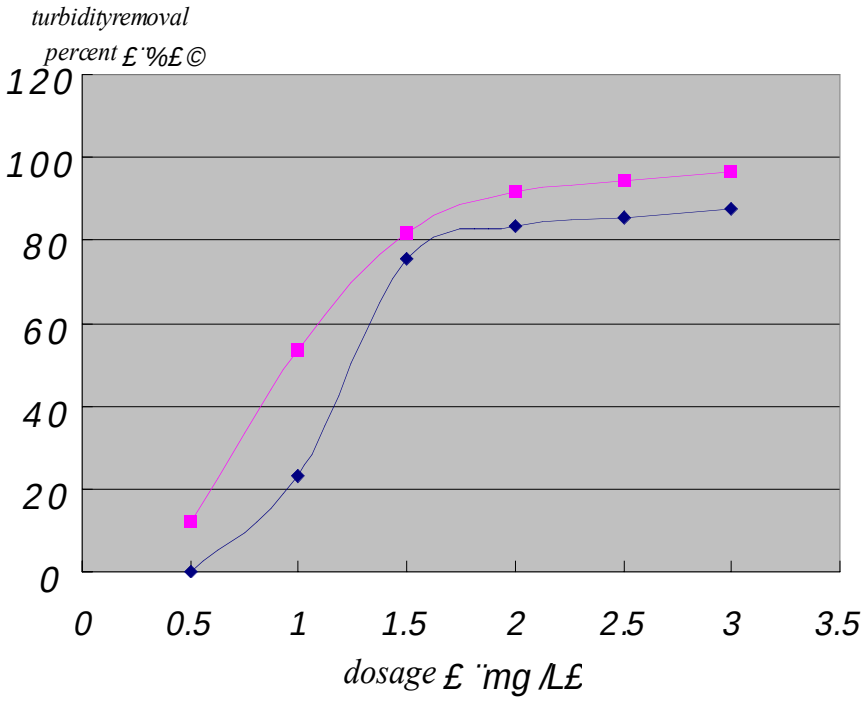

Fig.1 The relationship of turbidity removed percent with PAC dosage

2.1 The effect of settling time on turbidity removal percent

PAC with 8% of Al_2O_3 was added into 1000ml raw water to do coagulation experiment. Before its settling, a sample was taken and filled in a tube of the turbidity detector. Residual turbidity was detected every 5 minutes and a curve of residual turbidity vs settling time could be drawn in fig.2.

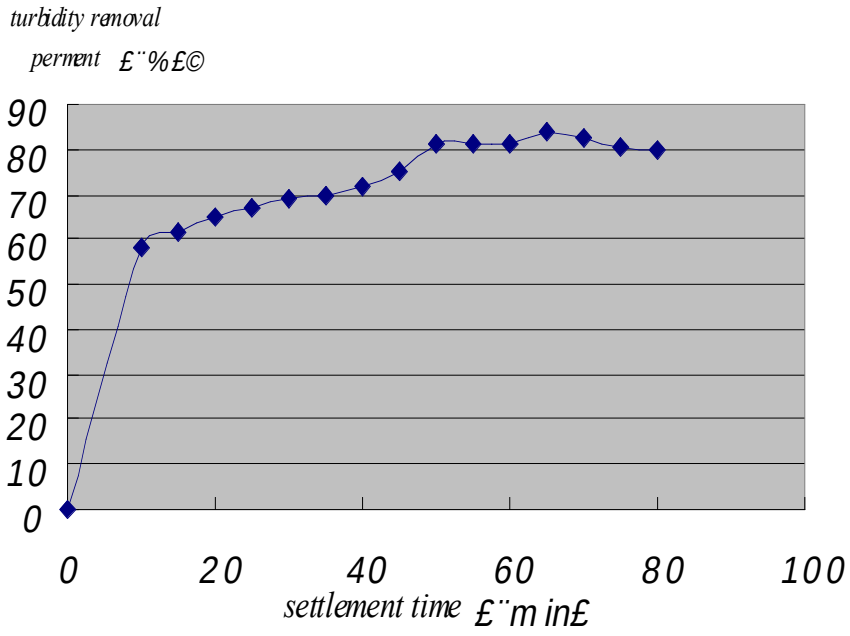

Fig.2 Residual turbidity vs settling time

Table 2 Relationship of turbidity removal percent with settling time

Settling time (min)	10	15	20	25	30	35	40
Residual turbidity	2.17	2.00	1.82	1.72	1.55	1.60	1.47
Turbidity removal percentage(_)	58.0	61.3	64.8	66.7	69.1	70.0	71.6
Settling time (min)	45	50	55	60	65	70	75
Residual turbidity	1.27	0.96	0.96	0.96	0.85	0.89	1.04
Turbidity removal percentage(_)	75.4	81.4	81.4	81.4	83.6	82.8	80.5

Note: Raw water turbidity is 5.17NTU (C_A_1.187mg_L).

The relationship curve of settling time turbidity removal percent with settling time was shown in fig.2.

The trend of turbidity variation could be seen clearly on the fig.2. In the first 20 minutes, the turbidity decreased quickly with a 60% turbidity removal ratio. Between 20-50 minutes, the turbidity decreased unclearly. After 50 minutes, the turbidity kept in about 1 NTU steadily.

The same result was obtained in the experiments with 10 times dilute solution and 100 times dilute solution in the condition of C_A1.187mg_L.

2.2 The effect of coagulant diluting times on coagulation

A coagulating experiment was done with the same raw water, the same Al_2O_3 concentration to compare the coagulation effect of PAC with 8% of Al_2O_3 liquid, 10 times dilute solution and 100 times dilute solution. The effect of coagulation diluting tines on coagulating effect was found.

Table 3 Effect of PAC dosage on turbidity removal percent

Dilute times	Dosage(mL)	20 min	40 min	60 min	80 min
1time	0.015	73.1_	89.1_	89.6_	93.0_
10times	0.15	70.7_	87.0_	91.1_	92.8_
100times	1.5	73.3_	88.9_	91.1_	93.5_

Note: C_A_1.425mg_L Raw water turbidity: 5.10NTU

A conclusion can be obtained from the two groups of data that there was no obvious difference in coagulation effect between raw PAC with 8% of Al_2O_3, 10 times dilute solution and 100 times dilute solution at the same concentration.

Table 4 Effect of PAC dosage on turbidity removal percent

Dilute times	Dose(mL)	20 min	40 min	60 min	80 min
1	0.015	85.2_	89.8_	92.2_	92.7_
10	0.15	80.6_	88.9_	91.7_	92.3_
100	1.5	82.1_	91.0_	91.4_	92.6_

Note: C_A_1.900mg_L Raw water turbidity 4.66NTU

3. CONCLUSIONS

The coagulating process is influenced by a series of variable factors, which include the physical and chemical properties of colloids and impurities in raw water, pH value, water temperature, coagulant variety, concentration, dosing mode and stirring condition, etc. Under the condition of the water's physical and chemical properties, coagulation's variety and rotation, the coagulation effect depends on two factors, coagulant dose variety and settlement time.

In a given settlement time, PAC dose determines the final rest turbidity. The final residual turbidity doesn't decrease continually as PAC dose increases. According to the experiment result, the optimal dose range is from 1.425 to 1.900mg/L for Al_2O_3. In the first 50 minutes of settlement time, the residual turbidity decreases with the settlement time increases. Over 50 minutes, the rest turbidity doesn't decreases continuously.

To increase PAC dosage and settlement time can improve the coagulation effect. For getting a treated water with a given turbidity increasing PAC dose suitably can shorten the settlement time and increase water output increasing the settlement time can decrease PAC dosage optimal operation efficiently and production cost. Based on its conditions water works can choose the parameter of PAC dosage and settlement time to reach the optimization purpose.

Water works' have different production condition. Water works should determine the optimal coagulating condition according to their own technological parameter and settlement curve.

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